Table 1
Groundwater Remediation Goals
Lockwood Solvent Groundwater Plume Site

Contaminant of Concern	Remediation Goal
Tetrachloroethene	5.0
Trichloroethene	5.0
cis-1,2-Dichloroethene	70.0
Vinyl chloride	2.0

Note:
All groundwater units are micrograms per liter

Table 2
Soil Remediation Goals
Lockwood Solvent Groundwater Plume Site

Contaminant of Concern	Remediation Goal	
	Beall Source Area	Brenntag Source Area
Tetrachloroethene	0.22	0.65
Trichloroethene	0.24	0.72
cis-1,2-Dichloroethene	1.64	4.90
Vinyl chloride	0.05	0.16

Note:
All soil units are milligram per kilogram

Table 3
Range of Detected Concentrations of Contaminants of Concern in Groundwater
Lockwood Solvent Groundwater Plume Site

Subarea	PCE	TCE	cis-1,2-DCE	VC
A	0.22J – 120,000	0.23J – 1,500	0.29J – 4,900	0.19J – 1,090
B	0.21J – 10.0	0.29J – 1,870	0.22J – 1,380	ND – 1.1J
C	0.26J – 3.96J	0.23J – 7.7	0.24J – 9.7J	ND
Remediation Goal	5	5	70	2

Notes:
All groundwater units are micrograms per liter
cis-1,2-DCE cis-1,2-dichloroethene
J Estimated value
ND Not detected
PCE Tetrachloroethene
TCE Trichloroethene
VC Vinyl chloride

Table 4
Range of Detected Concentrations of Contaminants of Concern in Surface and Subsurface Soil
Lockwood Solvent Groundwater Plume Site

Subarea	PCE	TCE	cis-1,2-DCE	VC
A	ND – 4,670	ND – 129	ND – 50	ND – 1.5
B	ND – 0.58J	ND – 2.1	ND – 4.0	ND
C	ND	ND	ND	ND

Notes:
All soil units are milligrams per kilogram
cis-1,2-DCE cis-1,2-dichloroethene
J Estimated value
ND Not detected
PCE Tetrachloroethene
TCE Trichloroethene
VC Vinyl chloride

Table 5
Range of Detected Concentrations of Contaminants of Concern in Surface Water and Sediment
Lockwood Solvent Groundwater Plume Site

Medium	PCE	TCE	cis-1,2-DCE	VC
Surface Water	ND – 27	ND – 4.1J	ND – 14	ND – 2.2
Sediment	ND	ND	ND	ND

Notes:
All surface water units are micrograms per liter
All sediment units are milligrams per kilogram
cis-1,2-DCE cis-1,2-dichloroethene
J Estimated value
ND Not detected
PCE Tetrachloroethene
TCE Trichloroethene
VC Vinyl chloride

Table 6
Range of Detected Concentrations of Contaminants of Concern in Indoor Air
Lockwood Solvent Groundwater Plume Site

Medium	PCE	TCE	cis-1,2-DCE	VC
Indoor Air	0.21 – 39.46	ND – 5.91	ND – 6.32	ND

Notes:
All indoor air units are micrograms per cubic meter
cis-1,2-DCE cis-1,2-dichloroethene
ND Not detected
PCE Tetrachloroethene
TCE Trichloroethene
VC Vinyl chloride

Table 7
Range of Detected Concentrations of Contaminants of Concern in Brenntag Vadose Soil
Lockwood Solvent Groundwater Plume Site

Medium	PCE	TCE	cis-1,2-DCE	VC
Vadose Soil	ND – 4,670	ND –129	ND – 50	ND – 0.38

Notes:
All vadose soil units are milligrams per kilogram
cis-1,2-DCE cis-1,2-dichloroethene
ND Not detected
PCE Tetrachloroethene
TCE Trichloroethene
VC Vinyl chloride

Table 8
Range of Detected Concentrations of Contaminants of Concern in Beall Vadose Soil
Lockwood Solvent Groundwater Plume Site

Medium	PCE	TCE	cis-1,2-DCE	VC
Vadose Soil	ND – 0.11J	ND – 1.7	ND – 1.2	ND

Notes:
All vadose soil units are milligrams per kilogram
cis-1,2-DCE cis-1,2-dichloroethene
J Estimated value
ND Not detected
PCE Tetrachloroethene
TCE Trichloroethene
VC Vinyl chloride

Table 9
Exposure Point Concentrations in Groundwater
Lockwood Solvent Groundwater Plume Site

Scenario Timeframe: Current/Future
Medium: Site-Wide Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical of Concern	Concentration Detected with qualifier		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Minimum	Maximum					
Alluvial Groundwater	Tetrachloroethene	0.13J	1980	µg/L	42/80	1980	µg/L	Max
	Trichloroethene	0.27	1850	µg/L	66/80	1850	µg/L	Max
	cis-1,2-dichloroethene	0.28J	2280	µg/L	64/80	2280	µg/L	Max
	Vinyl Chloride	0.33	252	µg/L	21/80	252	µg/L	Max

Notes:
J estimated concentration
µg/L micrograms per liter
Max Maximum Concentration

Table 10
Exposure Point Concentrations in Indoor Air
Lockwood Solvent Groundwater Plume Site

Scenario Timeframe: Current/Future
Medium: Indoor Air
Exposure Medium: Air

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Minimum	Maximum					
Indoor Air	Tetrachloroethene	0.2	39.46	ug/cm^3	15/15	39.46	µg/cm^3	Max
	Trichloroethene	0.15	5.91	ug/cm^3	11/15	3.11	µg/cm^3	95%UCL
	cis-1,2-dichloroethene	0.29	6.32	ug/cm^3	6/15	2.09	µg/cm^3	95%UCL

Notes:
95%UCL 95% Upper Confidence Limit
µg/cm^3 micrograms per cubic meter
Max Maximum Concentration

Table 11
Exposure Point Concentrations in Surface Water
Lockwood Solvent Groundwater Plume Site

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Point	Chemical of Concern	Concentration Detected with qualifier		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Minimum	Maximum					
Surface Water	Tetrachloroethene	0.13	27	µg/L	4/14	27	µg/L	Max
	Trichloroethene	0.23	4.1J	µg/L	13/14	4.1	µg/L	Max
	cis-1,2-dichloroethene	0.4	14	µg/L	5/14	14	µg/L	Max
	Vinyl Chloride	0.81	2.2	µg/L	3/14	2.2	µg/L	Max

Notes:
J estimated concentration
Max Maximum Concentration
µg/L micrograms per liter

Table 12
Selection of Exposure Pathways
Lockwood Solvent Groundwater Plume Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/ Future	Ground Water	Ground Water	Private Well Water (nonpotable use)	Resident	Adult	Ingestion	None	Residents with well concentrations above MCLs were connected to public water supplies in 2000 through emergency response actions; therefore, ingestion is not expected in the current scenario for residences on the public water supply. Residences not currently connected to the public water supply and the future use of groundwater as a potable source was evaluated.
						Dermal	Quantitative	Some residents use private wells seasonally for irrigation and washing cars.
				Resident	Adolescent	Ingestion	None	Residents with well concentrations above MCLs were connected to public water supplies in 2000 through emergency response actions; therefore, ingestion is not expected in the current scenario for residences on the public water supply. Residences not currently connected to the public water supply and the future use of groundwater as a potable source was evaluated.
						Dermal	Quantitative	Some residents use private wells to fill small wading pools seasonally for childrens' recreationa use, or allow children to play in sprinklers during summertime. For this scenario, it was assumed that children ages 6 through 16 would be most likely to engage in this type of activity.
				Industrial Worker	Adult	Ingestion	None	Well water is used for washing racks, hand washing, and facility maintenance/cleaning. Industrial wells with concentrations above MCLs are either connected to the public water supply or provide an alternate source of drinking water for employees.
						Dermal	Quantitative	Industrial worker use of well water for wash racks, hand washing, and facility maintenance/cleaning.
			Aquifer (Monitoring Well Access)	Trespasser	Adolescent	Ingestion	None	Trespasser cannot access wells; wells are padlocked and checked quarterly by DEQ contractors during monitoring for integrity.
						Dermal	None	Trespasser cannot access wells; wells are padlocked and checked quarterly by DEQ contractors during monitoring for integrity.
			Aquifer (Utility Maintenance)	Utility/ Construction Worker	Adult	Ingestion	None	Short-term exposure during utility trench dewatering is unlikely to result in incidental ingestion of seeping groundwater during emergency repairs. A longer-term "future" exposure of construction workers who might dig a future utility trench was evaluated.
						Dermal	None	Utility maintenance workers would be unlikely to contact seeping groundwater in a short-term exposure scenario to trigger a chronic risk, due to climate and need to wear protective gloves, clothing, and boots during emergency repairs. A longer-term "future" exposure of construction workers who might dig a future utility trench was evaluated.
	Ground Water	Indoor Air	Airborne vapors	Resident	Adult	Inhalation	Quantitative	Exposure to vapors in indoor air. This evaluation will include measured indoor air concentrations, which may include contributions from sources other than groundwater (for example, paint or solvent storage and the use of cleaning products).
					Child	Inhalation	Quantitative	Exposure to vapors in indoor air. This evaluation will include measured indoor air concentrations, which may include contributions from sources other than groundwater (for example, paint or solvent storage and the use of cleaning products).
				Industrial Worker	Adult	Inhalation	None	No indoor air measurements were made during current industrial operations. Present industria operations are largely "open-air" establishments such as truck maintenance bays.

Table 12
Selection of Exposure Pathways
Lockwood Solvent Groundwater Plume Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/ Future (continued)	Ground Water (continued)	Outdoor Air	Airborne vapors	Resident	Adult	Inhalation	Quantitative	Some residents use private wells seasonally for irrigation and washing cars.
					Child	Inhalation	Quantitative	Some residents use private wells to fill small wading pools seasonally for childrens' recreationa use, or allow children to play in sprinklers during summertime.
				Industrial Worker	Adult	Inhalation	Quantitative	Exposure to airborne vapors during industrial use of groundwater. Ventilated (i.e. outdoor air) conditions were assumed.
	Surface Water	Surface Water	Coulson Ditch	Recreator	Adolescent	Ingestion	Quantitative*	Incidental ingestion of surface water from Coulson Ditch possible during recreational use of the conveyance to catch small bait fish.
						Dermal	Quantitative*	Dermal absorption of surface water from Coulson Ditch possible during recreational use of the conveyance to catch small bait fish.
			AJ Gravel Pond	Recreator	Adolescent	Ingestion	Quantitative	Incidental ingestion of surface water from gravel pond during fishing. During past seasons, the gravel pond has been used (seasonally) for wading.
						Dermal	Quantitative	Dermal absorption of surface water from gravel pond during fishing and/or wading.
			Yellowstone River	Recreator	Adolescent	Ingestion	Quantitative*	"Sentinel wells" (groundwater wells immediately upgradient of the Yellowstone River bank) indicate that contaminants have reached the Yellowstone River.
						Dermal	Quantitative*	"Sentinel wells" (groundwater wells immediately upgradient of the Yellowstone River bank) indicate that contaminants have reached the Yellowstone River.
		Animal Tissue (Biota)	Fish from Coulson Ditch	Recreator	Adolescent	Ingestion	Qualitative	The Coulson irrigation ditch is used as a bait fish collection area, and since these fish are not for human consumption, this potential pathway is incomplete and was not quantified.
						Dermal	None	Exposure to contaminants in fish through the dermal pathway is unlikely.
			Fish from AJ Gravel Pond	Recreator	Adolescent	Ingestion	Quantitative	As the AJ Gravel pond has historically been stocked with fish, exposure via ingestion of fish tissue was quantitatively evaluated.
						Dermal	None	Exposure to contaminants in fish through the dermal pathway is unlikely.

Table 12
Selection of Exposure Pathways
Lockwood Solvent Groundwater Plume Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/ Future (continued)	Soil	Surface Soil (0-2 feet)	Potential "source areas"	Trespasser	Adolescent	Ingestion	Quantitative*	Incidental ingestion of surface soil by trespasser in "source area" locations.
						Dermal	Quantitative*	Dermal contact with surface soil by trespasser in "source area" locations.
				Industrial Worker	Adult	Ingestion	Quantitative*	Incidental ingestion of surface soil by industrial workers from industrial areas.
						Dermal	Quantitative*	Dermal contact with surface soil by industrial workers from industrial areas.
		Outdoor Air	Airborne particulates and vapors	Trespasser	Adolescent	Inhalation	Quantitative*	Exposure during outdoor activities over "source area" soils was considered.
				Resident	Adult	Inhalation	Quantitative*	Exposure during outdoor activities over "source area" soils was considered.
					Child	Inhalation	Quantitative*	Exposure during outdoor activities over "source area" soils was considered.
				Industrial Worker	Adult	Inhalation	Quantitative*	Exposure during outdoor activities over "source area" soils was considered.
	Sediment	Sediment	Coulson Ditch	Recreator	Adolescent	Ingestion	Quantitative*	Incidental ingestion of contaminated sediments from Coulson Ditch contacted during possible recreational use of conveyance to catch small bait fish.
						Dermal	Quantitative*	Dermal exposure to contaminated sediments from Coulson Ditch contacted during possible recreational use of conveyance to catch small bait fish.
			AJ Gravel Pond	Recreator	Adolescent	Ingestion	None	Although fishing may occur at the gravel pond, the pond substrate is mainly gravel (not sediment) and thus human contact with sediment (or any media that can be analyzed in the laboratory) is unlikely. No sediments could be sampled from AJ Gravel Pond.
						Dermal	None	Although fishing may occur at the gravel pond, the pond substrate is mainly gravel (not sediment) and thus human contact with sediment (or any media that can be analyzed in the laboratory) is unlikely. No sediments could be sampled from AJ Gravel Pond.
			Yellowstone River	Recreator	Adolescent	Ingestion	Quantitative*	The "cut bank" of the Yellowstone River is unlikely to have received groundwater-to-surface water contamination. No sampling data is available for sediment on the Yellowstone River bank.
						Dermal	Quantitative*	The "cut bank" of the Yellowstone River is unlikely to have received groundwater-to-surface water contamination. No sampling data is available for sediment on the Yellowstone River bank.

Table 12
Selection of Exposure Pathways
Lockwood Solvent Groundwater Plume Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/ Future (continued)	Ground Water	Ground Water	Private Well Tap Water	Resident	Adult	Ingestion	Quantitative	Residences not currently connected to the public water supply may use well water for whole-house use; also, no prohibition exists to prevent existing wells from being used for whole-house use or the installation of new wells by those currently connected to the public water supply (future use).
						Dermal	Quantitative	Residences not currently connected to the public water supply may use well water for whole-house use; also, no prohibition exists to prevent existing wells from being used for whole-house use or the installation of new wells by those currently connected to the public water supply (future use).
					Child	Ingestion	Quantitative	Residences not currently connected to the public water supply may use well water for whole-house use; also, no prohibition exists to prevent existing wells from being used for whole-house use or the installation of new wells by those currently connected to the public water supply (future use).
						Dermal	Quantitative	Residences not currently connected to the public water supply may use well water for whole-house use; also, no prohibition exists to prevent existing wells from being used for whole-house use or the installation of new wells by those currently connected to the public water supply (future use).
				Industrial Worker	Adult	Ingestion	Quantitative	Businesses not currently connected to the public water supply (and not supplying an alternate drinking water source) may use well water for potable use; also, no prohibition exists to prevent existing wells from being used for potable use or the installation of new wells by those currently connected to the public water supply or supplying an alternate drinking water source (future use).
						Dermal	Quantitative	Industrial worker use of well water for wash racks, hand washing, and facility maintenance/cleaning.
			Aquifer (Subsurface Construction)	Utility/ Construction Worker	Adult	Ingestion	Quantitative	Although short-term exposure during construction dewatering is unlikely to result in incidental ingestion of seeping groundwater, exposure during future subsurface construction or utility installation was considered.
						Dermal	Quantitative	Although short-term exposure during construction dewatering is unlikely to result in demal contact with seeping groundwater, exposure during future subsurface construction or utility installation was considered.
		Indoor Air	Airborne vapors	Resident	Adult	Inhalation	Quantitative	Residents not currently connected to the public water supply may use well water for whole-house use, including during bathing, washing, and showering. This scenario differs from the current/future indoor air resident (connected to the public water supply) because for these residents, the only contribution to indoor air concentrations is assumed to be from the plume underlying homes. In contrast, use of groundwater in homes not connected to the public water supply would add to the indoor air loading due to use of contaminated water indoors.
					Child	Inhalation	Quantitative	Residents not currently connected to the public water supply may use well water for whole-house use, including during bathing, washing, and showering. Because children age 6 and under generally do not take showers (and rather, take baths instead), a shower dispersion model will not be quantitatively evaluated.
		Outdoor Air	Airborne vapors	Utility/ Construction Worker	Adult	Inhalation	Quantitative	Possibility of a future construction worker breathing vapors from volatile chemicals present in ground water seeping into areas under construction (excavation).

Table 12
Selection of Exposure Pathways
Lockwood Solvent Groundwater Plume Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/ Future (continued)	Soil	Surface (0-2 feet bgs) and Subsurface (2-10 feet bgs) Soil	"Source Areas"	Utility/ Construction Worker	Adult	Ingestion	Quantitative*	Incidental ingestion of surface or subsurface soil by future construction workers from "source areas" or areas of potential subsurface migration.
						Dermal	Quantitative*	Dermal contact with surface or subsurface soil by future construction workers from "source areas" or areas of potential subsurface migration.
				Resident	Child	Ingestion	Quantitative*	Incidental ingestion of presently industrial "source area" soils by future residents after redevelopment, which is assumed to include grading and possible mixing of currently subsurface soils into the residential yard surface soil.
						Dermal	Quantitative*	Dermal contact with presently industrial "source area" soils by future residents after redevelopment, which is assumed to include grading and possible mixing of currently subsurface soils into the residential yard surface soil.
					Adult	Ingestion	Quantitative*	Incidental ingestion of presently industrial "source area" soils by future residents after redevelopment, which is assumed to include grading and possible mixing of currently subsurface soils into the residential yard surface soil.
						Dermal	Quantitative*	Dermal contact with presently industrial "source area" soils by future residents after redevelopment, which is assumed to include grading and possible mixing of currently subsurface soils into the residential yard surface soil.
		Air	Airborne particulates and vapors	Utility/ Construction Worker	Adult	Inhalation	Quantitative*	Exposure to airborne particulates or vapors from subsurface construction (to a depth of 10 feet) in "source areas" or areas of potential subsurface migration.
				Resident	Child	Inhalation	Quantitative*	Inhalation of soil vapors and particulates from presently industrial "source area" soils by future residents after redevelopment, which is assumed to include grading and possible mixing of currently subsurface soils into the residential yard surface soil.
					Adult	Inhalation	Quantitative*	Inhalation of soil vapors and particulates from presently industrial "source area" soils by future residents after redevelopment, which is assumed to include grading and possible mixing of currently subsurface soils into the residential yard surface soil.

Notes:

*	Indicates a quantitative evaluation was considered, but no contaminants of concern were identified for the relevant medium.
bgs	Below ground surface
DEQ	Montana Department of Environmental Quality
MCL	Maximum Contaminant Level
PWS	Public water supply

Table 13
Non-Cancer Toxicity Data Summary
Lockwood Solvent Groundwater Plume Site

Pathway: Oral/Dermal

Chemical of Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Dermal RfD	Dermal RfD Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ
Tetrachloroethene	Chronic	1.00E-02	(mg/kg)/day	1.00E-02	(mg/kg)/day	Liver	1000	IRIS	01/27/2003
Trichloroethene	Chronic	6.00E-03	(mg/kg)/day	6.00E-03	(mg/kg)/day	Liver	--	R9-2000[a]	2000
cis-1,2-dichloroethene	Chronic	1.00E-02	(mg/kg)/day	1.00E-02	(mg/kg)/day	Blood	3000	HEAST	1997
Vinyl chloride	Chronic	3.00E-03	(mg/kg)/day	1.00E-02	(mg/kg)/day	Liver	30	IRIS	01/23/2003

Pathway: Inhalation

Chemical of Concern	Chronic/ Subchronic	Inhalation RfC	Inhalation RfC Units	Inhalation RfD	Inhalation RfD Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfC/RfD: Target Organ	Dates of RfC/RfD: Target Organ
Tetrachloroethene	Chronic	6.00E-01	mg/m^3	--	--	Kidney	30	R9-NCEA	2002
Trichloroethene	Chronic	2.10E-02	mg/m^3	--	--	CNS/PNS	--	R9-2000[a]	2000
cis-1,2-dichloroethene	Chronic	3.50E-02	mg/m^3	--	--	Blood	3000	R-R9	2002
Vinyl chloride	Chronic	1.00E-01	mg/m^3	--	--	Liver	30	IRIS	01/23/2003

Notes:
a Toxicity value shown is the toxicity value effective prior to October 1, 2002.

--: not available
CNS/PNS: Central Nervous System/Peripheral Nervous System
HEAST: Health Effects Assessment Summary Table
IRIS: Integrated Risk Information System. Accessed January 2003. Available on-line at: http//www.epa.gov/iris/index.html
RfC: Reference concentration
RfD: Reference dose, oral or inhalation, as appropriate
R-R9: Route-to-route extrapolated from an oral reference dose – Region 9
R9-2000: "Region 9 Preliminary Remediation Goals." November.
R9-NCEA: Region 9 – National Center for Environmental Assessment
(mg/kg)/day: milligram per kilogram per day
mg/m^3: milligram per cubic meter

Table 14
Cancer Toxicity Data Summary
Lockwood Solvent Groundwater Plume Site

Pathway: Oral/Dermal

Chemical of Concern	Oral Cancer Slope Factor	Dermal Cancer Slope Factor	Slope Factor Units	Weight of Evidence/Cancer Guideline Description	Source	Date
Tetrachloroethene	5.20E-02	5.20E-02	(mg/kg)/day	C-B2[a]	NCEA	2001
Trichloroethene	1.10E-02	1.10E-02	(mg/kg)/day	--	R9-2000[b]	1994/2002
cis-1,2-dichloroethene	--	--	--	D	IRIS	01/23/2003
Vinyl chloride	1.50E+00	1.50E+00	(mg/kg)/day	A	IRIS[c]	01/23/2003

Pathway: Inhalation

Chemical of Concern	Unit Risk	Units	Inhalation Cancer Slope Factor	Units	Weight of Evidence/Cancer Guideline Description	Source	Date
Tetrachloroethene	5.8E-04	mg/m^3	--	--	C-B2[a]	R8	2001
Trichloroethene	1.7E-03	mg/m^3	--	--	--	R9-2000[b]	1994/2002
cis-1,2-dichloroethene	--	--	--	--	D	IRIS	12/26/2002
Vinyl chloride	8.8E-03	mg/m^3	--	--	A	IRIS[c]	01/23/2003

Notes:

a According to the Superfund Technical Support Center, the PCE weight-of-evidence classification is on the C-B2 continuum. At the present time, the Agency has not adopted a final position on the weight-of-evidence classification.

b Toxicity value shown is the toxicity value effective prior to October 1, 2002.

c The vinyl chloride inhalation cancer slope factor (calculated from an air unit risk factor) for continuous lifetime exposure from birth was used to estimate risks for the residential/recreational scenarios.

--: not available
IRIS: Integrated Risk Information System. Accessed January 2003. Available on-line at: http//www.epa.gov/iris/index.html
NCEA: National Center for Environmental Assessment
R8: Electronic memorandums transmitted between Region 8 toxicologists and project managers.
R9-2000: "Region 9 Preliminary Remediation Goals." November.
(mg/kg)/day: milligram per kilogram per day
mg/m^3: milligram per cubic meter

EPA Weight of Evidence Classification:
A – Human carcinogen
B1 – Probable human carcinogen – indicates limited human data are available
B2 – Probable human carcinogen – indicates sufficient evidence in animals and inadequate or no evidence in humans
C – Possible human carcinogen
D – Not classifiable as to human carcinogenicity

TABLE 15
CALCULATION OF CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
LOCKWOOD SOLVENT GROUNDWATER PLUME SITE

Scenario Timeframe:	Current
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Cancer			Noncancer			
				Dermal Risk	Inhalation(1) Risk	Total of Routes	Target Organ	Dermal Hazard	Inhalation Hazard	Total of Routes
Groundwater Area A Source	Groundwater	Tap	CIS-1,2-DICHLOROETHENE	--	--	0.E+00	Liver	0.25	0.01	0.26
			TETRACHLOROETHENE	2.E-04	4.E-08	2.E-04	Liver, Kidney	1.24	0.00	1.24
			TRICHLOROETHENE	1.E-06	9.E-09	1.E-06	Liver, Kidney	0.05	0.00	0.05
			VINYL CHLORIDE	5.E-05	1.E-11	5.E-05	Liver	0.07	0.00	0.07
			Exp. Route Total	**3.E-04**	**5.E-08**	**3.E-04**		**1.61**	**0.01**	**1.62**
		Exposure Point Total				**3.E-04**				**1.62**
	Exposure Medium Total					**3.E-04**				**1.62**
Groundwater Total						**3.E-04**				**1.62**
Total of Receptor Hazards Across All Media						**3.E-04**				**1.62**

Notes:

(1) Volatiles from groundwater to outdoor air

TABLE 16
CALCULATION OF CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
LOCKWOOD SOLVENT GROUNDWATER PLUME SITE

Scenario Timeframe:	Future
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Cancer				Noncancer				
				Ingestion Risk	Dermal(1) Risk	Inhalation(2) Risk	Total of Routes	Target Organ	Ingestion Hazard	Dermal(1) Hazard	Inhalation(2) Hazard	Total of Routes
Groundwater Area A Source	Groundwater	Tap	CIS-1,2-DICHLOROETHENE	--	--	--	--	Liver	3.12	0.25	0.01	3.38
			TETRACHLOROETHENE	5.E-04	2.E-04	5.E-08	7.E-04	Liver, Kidney	2.71	1.24	0.00	3.96
			TRICHLOROETHENE	8.E-06	1.E-06	1.E-08	9.E-06	Liver, Kidney	0.34	0.05	0.00	0.39
			VINYL CHLORIDE	9.E-04	5.E-05	1.E-11	9.E-04	Liver	1.15	0.07	0.00	1.22
			Exp. Route Total	**1.E-03**	**3.E-04**	**7.E-08**	**2.E-03**		**7.33**	**1.61**	**0.01**	**8.95**
		Exposure Point Total					**2.E-03**					**8.95**
	Exposure Medium Total						**2.E-03**					**8.95**
Groundwater Total							**2.E-03**					**8.95**
Total of Receptor Hazards Across All Media							**2.E-03**					**8.95**

Notes:

(1) Facility cleaning operations
(2) Volatiles from groundwater to outdoor air

TABLE 17
CALCULATION OF CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
LOCKWOOD SOLVENT GROUNDWATER PLUME SITE

Scenario Timeframe:	Future
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Cancer				Noncancer				
				Ingestion Risk	Dermal(1) Risk	Inhalation(2) Risk	Total of Routes	Target Organ	Ingestion Hazard	Dermal(1) Hazard	Inhalation(2) Hazard	Total of Routes
Groundwater Area B Source	Groundwater	Tap	CIS-1,2-DICHLOROETHENE	--	--	--	--	Liver	1.89	0.17	0.00	2.06
			TETRACHLOROETHENE	2.E-06	7.E-07	1.E-10	2.E-06	Liver, Kidney	0.01	0.00	0.00	0.01
			TRICHLOROETHENE	1.E-04	1.E-05	1.E-07	1.E-04	Liver, Kidney	4.22	0.61	0.01	4.84
			VINYL CHLORIDE	1.E-06	9.E-08	2.E-14	2.E-06	Liver	0.00	0.00	0.00	0.00
			Exp. Route Total	**1.E-04**	**2.E-05**	**1.E-07**	**1.E-04**		**6.12**	**0.78**	**0.01**	**6.92**
		Exposure Point Total					**1.E-04**					**6.92**
	Exposure Medium Total						**1.E-04**					**6.92**
Groundwater Total							**1.E-04**					**6.92**
Total of Receptor Hazards Across All Media							**1.E-04**					**6.92**

Notes:

(1) Facility cleaning operations
(2) Volatiles from groundwater to outdoor air

TABLE 18
CALCULATION OF CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
LOCKWOOD SOLVENT GROUNDWATER PLUME SITE

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Cancer				Noncancer				
				Ingestion Risk	Dermal(1) Risk	Inhalation(2) Risk	Total of Routes	Target Organ	Ingestion Hazard	Dermal(1) Hazard	Inhalation(2) Hazard	Total of Routes
Groundwater Area A Source	Groundwater	Tap	CIS-1,2-DICHLOROETHENE	--	--	--	--	Liver	6.25	--	0.75	7.00
			TETRACHLOROETHENE	1.E-03	6.E-04	5.E-06	2.E-03	Liver, Kidney	5.42	3.44	0.04	8.90
			TRICHLOROETHENE	2.E-05	3.E-06	1.E-06	2.E-05	Liver, Kidney	0.69	0.12	0.08	0.89
			VINYL CHLORIDE	4.E-03	--	9.E-09	4.E-03	Liver	2.30	--	0.03	2.33
			Exp. Route Total	**5.E-03**	**6.E-04**	**6.E-06**	**5.E-03**		**14.66**	**3.56**	**0.91**	**19.12**
		Exposure Point Total					**5.E-03**					**19.12**
	Exposure Medium Total						**5.E-03**					**19.12**
Groundwater Total							**5.E-03**					**19.12**
Indoor Air	Indoor Air	Indoor	CIS-1,2-DICHLOROETHENE			--	--	Liver			0.06	0.06
			TETRACHLOROETHENE			8.E-06	8.E-06	Liver, Kidney			0.06	0.06
			TRICHLOROETHENE			2.E-06	2.E-06	Liver, Kidney			0.14	0.14
			Exp. Route Total			**9.E-06**	**9.E-06**				**0.26**	**0.26**
		Exposure Point Total					**9.E-06**					**0.26**
	Exposure Medium Total						**9.E-06**					**0.26**
Indoor Air Total							**9.E-06**					**0.26**
Total of Receptor Hazards Across All Media							**5.E-03**					**19.38**

Notes:

(1) During showering
(2) Volatiles during showering for groundwater exposure medium

TABLE 19
CALCULATION OF CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
LOCKWOOD SOLVENT GROUNDWATER PLUME SITE

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Cancer				Noncancer				
				Ingestion Risk	Dermal(1) Risk	Inhalation(2) Risk	Total of Routes	Target Organ	Ingestion Hazard	Dermal(1) Hazard	Inhalation(2) Hazard	Total of Routes
Groundwater Area A Source	Groundwater	Tap	CIS-1,2-DICHLOROETHENE	--	--	--	--	Liver	14.58	--	1.30	15.88
			TETRACHLOROETHENE	6.E-04	2.E-04	2.E-06	8.E-04	Liver, Kidney	12.66	4.68	0.07	17.40
			TRICHLOROETHENE	9.E-06	9.E-07	4.E-07	1.E-05	Liver, Kidney	1.60	0.16	0.14	1.91
			VINYL CHLORIDE	2.E-03	--	4.E-09	2.E-03	Liver	5.37	--	0.05	5.42
			Exp. Route Total	**3.E-03**	**2.E-04**	**2.E-06**	**3.E-03**		**34.20**	**4.84**	**1.56**	**40.61**
		Exposure Point Total					**3.E-03**					**40.61**
	Exposure Medium Total						**3.E-03**					**40.61**
Groundwater Total							**3.E-03**					**40.61**
Indoor Air	Indoor Air	Indoor	CIS-1,2-DICHLOROETHENE			--	--	Liver			0.06	0.06
			TETRACHLOROETHENE			2.E-06	2.E-06	Liver, Kidney			0.06	0.06
			TRICHLOROETHENE			4.E-07	4.E-07	Liver, Kidney			0.14	0.14
			Exp. Route Total			**2.E-06**	**2.E-06**				**0.26**	**0.26**
		Exposure Point Total					**2.E-06**					**0.26**
	Exposure Medium Total						**2.E-06**					**0.26**
Indoor Air Total							**2.E-06**					**0.26**
Total of Receptor Hazards Across All Media							**3.E-03**					**41.96**

Notes:

(1) During bathing
(2) Volatiles during bathing for groundwater exposure medium

TABLE 20
CALCULATION OF CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
LOCKWOOD SOLVENT GROUNDWATER PLUME SITE

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Cancer				Noncancer				
				Ingestion Risk	Dermal(1) Risk	Inhalation(2) Risk	Total of Routes	Target Organ	Ingestion Hazard	Dermal(1) Hazard	Inhalation(2) Hazard	Total of Routes
Groundwater Area B Source	Groundwater	Tap	CIS-1,2-DICHLOROETHENE	--	--	--	--	Liver	3.78	0.35	0.46	4.58
			TETRACHLOROETHENE	3.E-06	2.E-06	1.E-08	5.E-06	Liver, Kidney	0.02	0.01	0.00	0.03
			TRICHLOROETHENE	2.E-04	3.E-05	1.E-05	2.E-04	Liver, Kidney	8.45	1.48	1.02	10.95
			VINYL CHLORIDE	6.E-06	--	1.E-11	6.E-06	Liver	0.00	--	0.00	0.00
			Exp. Route Total	**2.E-04**	**4.E-05**	**1.E-05**	**2.E-04**		**12.25**	**1.84**	**1.48**	**15.56**
		Exposure Point Total					**2.E-04**					**15.56**
	Exposure Medium Total						**2.E-04**					**15.56**
Groundwater Total							**2.E-04**					**15.56**
Indoor Air	Indoor Air	Indoor	CIS-1,2-DICHLOROETHENE			--	--	Liver			0.01	0.01
			TETRACHLOROETHENE			7.E-10	7.E-10	Liver, Kidney			0.00	0.00
			TRICHLOROETHENE			5.E-07	5.E-07	Liver, Kidney			0.04	0.04
			Exp. Route Total			**5.E-07**	**5.E-07**				**0.05**	**0.05**
		Exposure Point Total					**5.E-07**					**0.05**
	Exposure Medium Total						**5.E-07**					**0.05**
Indoor Air Total							**5.E-07**					**0.05**
Total of Receptor Hazards Across All Media							**2.E-04**					**15.61**

Notes:

(1) During showering
(2) Volatiles during showering for groundwater exposure medium

TABLE 21
CALCULATION OF CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
LOCKWOOD SOLVENT GROUNDWATER PLUME SITE

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Cancer				Noncancer				
				Ingestion Risk	Dermal(1) Risk	Inhalation(2) Risk	Total of Routes	Target Organ	Ingestion Hazard	Dermal(1) Hazard	Inhalation(2) Hazard	Total of Routes
Groundwater Area B Source	Groundwater	Tap	CIS-1,2-DICHLOROETHENE	--	--	--	--	Liver	8.82	0.49	0.79	10.10
			TETRACHLOROETHENE	2.E-06	4.E-08	6.E-09	2.E-06	Liver, Kidney	0.04	0.01	0.00	0.05
			TRICHLOROETHENE	1.E-04	8.E-07	5.E-06	1.E-04	Liver, Kidney	19.71	2.01	1.76	23.48
			VINYL CHLORIDE	3.E-06	--	6.E-12	3.E-06	Liver	0.01	--	0.00	0.01
			Exp. Route Total	**1.E-04**	**8.E-07**	**5.E-06**	**1.E-04**		**28.58**	**2.52**	**2.55**	**33.64**
		Exposure Point Total					**1.E-04**					**33.64**
	Exposure Medium Total						**1.E-04**					**33.64**
Groundwater Total							**1.E-04**					**33.64**
Indoor Air	Indoor Air	Indoor	CIS-1,2-DICHLOROETHENE			--	--	Liver			0.01	0.01
			TETRACHLOROETHENE			2.E-10	2.E-10	Liver, Kidney			0.00	0.00
			TRICHLOROETHENE			1.E-07	1.E-07	Liver, Kidney			0.04	0.04
			Exp. Route Total			**1.E-07**	**1.E-07**				**0.05**	**0.05**
		Exposure Point Total					**1.E-07**					**0.05**
	Exposure Medium Total						**1.E-07**					**0.05**
Indoor Air Total							**1.E-07**					**0.05**
Total of Receptor Hazards Across All Media							**1.E-04**					**33.70**

Notes:

(1) During showering
(2) Volatiles during showering for groundwater exposure medium

TABLE 22
ASSEMBLY OF COMPREHENSIVE REMEDIAL ALTERNATIVES
LOCKWOOD SOLVENT GROUNDWATER PLUME SITE

		Comprehensive Alternative							
Area	**Element**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Common Elements	Community information and education		X	X	X	X	X	X	X
	Controlled groundwater area		X	X	X	X	X	X	X
	CERCLA 5-year reviews		X	X	X	X	X	X	X
	Public water supply/well head protection		X	X	X	X	X	X	X
Site-Wide Groundwater	Monitored natural attenuation			X	X	X	X	X	X
	In-situ enhanced bioremediation				X		X		X
Brenntag Source Area Groundwater	Permeable reactive barrier						X	X	X
	Air sparge/soil vapor extraction					X			
	In-situ enhanced bioremediation				X		X		X
Brenntag Source Area Soil	Soil vapor extraction					X		X	
	Excavation and thermal desorption			X			X		X
	In-situ chemical oxidation						X	X	X
Beall Source Area Groundwater	Permeable reactive barrier							X	X
	Air sparge/soil vapor extraction					X			
	In-situ enhanced bioremediation				X		X		X
Beall Source Area Plume Leading Edge	Hydraulic barrier							X	
	Air sparge/soil vapor extraction					X			X
	In-situ enhanced bioremediation				X		X		
Beall Source Area Soil	Soil vapor extraction					X	X	X	
	Excavation and thermal desorption			X					X
	In-situ chemical oxidation							X	X

Table 23
Estimated Time to Reach Remediation Goals
Lockwood Solvent Groundwater Plume Site

Alternative	Beall Source Area Soil	Beall Source Area Groundwater	Brenntag Source Area Soil	Brenntag Source Area Groundwater	Site-Wide Groundwater
1	Not in long term	Not in long term	Not in long term	Not in long term	Not in long term
2	Not in long term	Not in long term	Not in long term	Not in long term	Not in long term
3	1 year	Not in long term	1 year	Not in long term	Not in long term
4	Not in long term	Not in long term	Not in long term	Not in long term	9 years
5	5 years	Not in long term	Not in long term	Not in long term	10 to 24 years
6	5 years	Long term	1 year	Long term	9 years
7	5 years	Long term	5 years	Long term	10 to 24 years
8	1 year	Long term	1 year	Long term	9 years

Table 24
Cost Estimates Summary for Alternatives
Lockwood Solvent Groundwater Plume Site

Alternative	Capital Cost	Annual O&M Cost	Periodic Cost	Total Present Worth Cost
1	$0	$0	$42,011	$90,600
2	$119,625	$63,730	$42,011	$698,200
3	$3,722,268	$396,378	$42,011	$7,046,700
4	$2,495,877	$780,810	$1,219,740	$9,905,600
5	$3,722,344	$1,256,362	$42,011	$13,466,500
6	$6,202,814	$1,012,352	$2,848,504	$14,453,800
7	$7,767,544	$1,090,416	$4,124,480	$16,576,800
8	$12,417,577	$821,313	$4,899,271	$20,372,500

Table 25
Comparative Analysis of Alternatives Summary
Lockwood Solvent Groundwater Plume Site

Assessment Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8
Overall Protectiveness								
Public Health, Safety, and Welfare	No reduction in risk. Not protective.	Protective to the extent institutional controls prevent the use of groundwater.	Protective. Relies upon institutional controls.	Protective. Relies upon institutional controls.	Protective.	Protective.	Protective.	Protective.
Environmental Protectiveness	Not protective.	Protective.	Protective.	Protective.	Protective.	Protective.	Protective.	Protective.
Compliance with ARARs								
Contaminant-Specific	Contaminant-specific ARARs will not be met in groundwater and surface water.	Contaminant-specific ARARs will not be met in groundwater and surface water.	Contaminant-specific ARARs may not be met in groundwater and surface water.	Contaminant-specific ARARs may not be met in groundwater.	Contaminant-specific ARARs may not be met in groundwater.	Contaminant-specific ARARs expected to be met over long-term.	Contaminant-specific ARARs expected to be met over long-term.	Contaminant-specific ARARs expected to be met over long-term.
Location-Specific	None apply.	Location-specific ARARs would be met.	Location-specific ARARs would be met.	Location-specific ARARs would be met.	Location-specific ARARs would be met.	Location-specific ARARs would be met.	Location-specific ARARs would be met.	Location-specific ARARs would be met.
Action-Specific	None apply.	Action-specific ARARs would be met.	Action-specific ARARs would be met.	Action-specific ARARs would be met.	Action-specific ARARs would be met.	Action-specific ARARs would be met.	Action-specific ARARs would be met.	Action-specific ARARs would be met.
Long-Term Effectiveness and Permanence								
Magnitude of Residual Risk	No reduction in COC levels in any environmental media.	No reduction in COC levels in any environmental media.	No reduction of COC levels in surface water or groundwater. No residual risk in soil.	Residual risk in groundwater above levels considered acceptable. No reduction of residual risk in soil.	Residual risk in source area groundwater and soil at the Brenntag source area above levels considered acceptable.	Residual risk reduced to acceptable levels over the long term.	Residual risk reduced to acceptable levels over the long term.	Residual risk reduced to acceptable levels over the long term.
Adequacy and Reliability of Controls	No controls implemented.	Institutional controls considered moderately reliable.	Institutional controls considered moderately reliable.	Institutional controls considered moderately reliable.	Institutional controls considered moderately reliable.	No controls necessary to manage residual risk over the long term.	No controls necessary to manage residual risk over the long term.	No controls necessary to manage residual risk over the long term.

Table 25
Comparative Analysis of Alternatives Summary
Lockwood Solvent Groundwater Plume Site

Assessment Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8
Reduction of Toxicity, Mobility, and Volume through Treatment								
Treatment Process Used and Materials Treated	None.	None.	Thermal desorption used to treat soils. Natural attenuation used to treat groundwater.	No treatment of soil. Groundwater treated with enhanced bioremediation.	Soil treated with SVE. Groundwater treated with air sparging/SVE and natural attenuation.	Soil treated with SVE, thermal desorption, and in-situ chemical oxidation. Groundwater treated with zero-valent iron, enhanced bioremediation, and natural attenuation.	Soil treated with SVE and in-situ chemical oxidation. Groundwater treated with zero-valent iron and natural attenuation.	Soil treated with thermal desorption and in-situ chemical oxidation. Groundwater treated with zero-valent iron, air sparging/SVE, enhanced bioremediation, and natural attenuation.
Reduction in Chemical Mobility	None.	None.	Thermal desorption greatly reduces mobility of chemicals from soil to groundwater. Monitored natural attenuation does not reduce mobility of chemicals in groundwater.	None.	Migration of chemicals from vadose soil to groundwater greatly reduced. Mobility of chemicals in groundwater reduced.	Migration of chemicals from vadose soil to groundwater greatly reduced. Mobility of chemicals in groundwater reduced.	Migration of chemicals from vadose soil to groundwater greatly reduced. Mobility of chemicals in groundwater reduced; greatly reduced in Beall source area plume leading edge.	Migration of chemicals from vadose soil to groundwater greatly reduced. Mobility of chemicals in groundwater reduced.
Volume of Contaminated Materials Treated	None.	None.	20,302 cubic yards of soil treated. Over 136 million gallons of groundwater treated.	No soil treated. More than 136 million gallons of groundwater treated.	Less than 20,302 cubic yards of soil treated. More than 136 million gallons of groundwater treated.	More than 20,302 cubic yards of soil treated. More than 136 million gallons of groundwater treated.	More than 20,302 cubic yards of soil treated. More than 136 million gallons of groundwater treated.	More than 20,302 cubic yards of soil treated. More than 136 million gallons of groundwater treated.

Table 25
Comparative Analysis of Alternatives Summary
Lockwood Solvent Groundwater Plume Site

Assessment Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8
Reduction of Toxicity, Mobility, and Volume through Treatment (continued)								
Expected Degree of Reduction of Toxic Chemicals	None.	None.	Chemical reduced to RAOs in soil. Chemicals reduced in surface water and groundwater but not to RAOs in all areas.	No significant chemical reduction in soil. Chemicals reduced in surface water to RAOs; reduced in groundwater but not to RAOs in all areas.	Chemicals reduced in soil but not to RAOs in all areas. Chemicals reduced in surface water to RAOs; reduced in groundwater but not to RAOs in all areas.	Chemicals reduced to RAOs in soil, groundwater and surface water.	Chemicals reduced to RAOs in soil, groundwater and surface water.	Chemicals reduced to RAOs in soil, groundwater and surface water.
Short-Term Effectiveness								
Protection of Community During Remedial Action	None.	Protection adequate.	Protection adequate.	Protection adequate.	Protection adequate.	Protection adequate.	Protection adequate.	Protection adequate.
Protection of On-Site Workers During Remedial Action	None.	Protection adequate.	Protection adequate.	Protection adequate.	Protection adequate.	Protection adequate.	Protection adequate.	Protection adequate.
Protection of the Environment During Remedial Action	None.	Protection adequate.	Protection adequate.	Protection adequate.	Protection adequate.	Protection adequate.	Protection adequate.	Protection adequate.

Table 25
Comparative Analysis of Alternatives Summary
Lockwood Solvent Groundwater Plume Site

Assessment Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8
Short-Term Effectiveness (continued)								
Time Until Remedial Action Objectives are Achieved	RAOs not achieved.	RAOs not achieved.	RAOs achieved in soil within one year. RAOs not achieved in groundwater or surface water.	RAOs not achieved in soil. RAOs achieved in groundwater and surface water downgradient of source areas within nine years. RAOs not achieved in groundwater in source areas.	RAOs achieved in soil at Beall source area within five years; RAOs not achieved in all soil at Brenntag source area. RAOs achieved in groundwater and surface water downgradient of Brenntag area in about 10 years; RAOs not achieved within source area. RAOs achieved in groundwater downgradient of Beall area in about 24 years; RAOs achieved in Beall source area over the long term.	RAOs achieved in soil at Beall source area within five years; RAOs achieved in soil at Brenntag source area in one year. RAOs achieved in groundwater and surface water downgradient of the source areas within nine years. RAOs achieved in groundwater in source areas over the long term.	RAOs achieved in source area soil within five years. RAOs achieved in groundwater and surface water downgradient of Brenntag source area in about 10 years. RAOs achieved in groundwater downgradient of Beall source area in about 24 years. RAOs achieved in groundwater in source areas over the long term.	RAOs achieved in soil in one year. RAOs achieved in groundwater and surface water downgradient of source areas within about nine years. RAOs achieved in groundwater at source areas over the long term.

Table 25
Comparative Analysis of Alternatives Summary
Lockwood Solvent Groundwater Plume Site

Assessment Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8
Implementability								
Ability to Construct and Operate	Not applicable.	Institutional controls easy to implement.	Soil excavation difficult due to proximity to operating facilities and due to depth in Beall source area. Common elements and monitored natural attenuation easy to implement.	Enhanced bioremediation easy to construct and operate. Common elements and monitored natural attenuation easy to implement.	Air sparging considered easy to construct. SVE moderately difficult to construct due to proximity to operating facilities. Systems easy to operate. Common elements and monitored natural attenuation easy to implement.	Soil excavation moderately difficult to implement due to proximity to operating facilities. Thermal treatment easy to operate. SVE easy to operate. PRB moderately difficult to construct; easy to operate. Enhanced bioremediation easy to construct and operate. In-situ chemical oxidation easy to construct and operate. Common elements and monitored natural attenuation easy to implement.	SVE moderately difficult to construct due to proximity to operating facilities. SVE easy to operate. PRB moderately difficult to construct in Brenntag area; difficult to construct in Beall area due to depths. PRBs easy to operate. Hydraulic barrier easy to construct and operate. In-situ chemical oxidation easy to construct and operate. Common elements and monitored natural attenuation easy to implement.	Soil excavation moderately difficult to implement due to proximity to operating facilities and due to depth in Beall source area. Thermal treatment easy to operate. PRB moderately difficult to construct in Brenntag area; difficult to construct in Beall area due to depths. PRBs easy to operate. Air sparge/SVE easy to construct and operate. Enhanced bioremediation easy to construct and operate. In-situ chemical oxidation easy to construct and operate. Common elements and monitored natural attenuation easy to implement.

Table 25
Comparative Analysis of Alternatives Summary
Lockwood Solvent Groundwater Plume Site

Assessment Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8
Implementability (continued)								
Reliability of Technology	Not applicable.	Moderately reliable.	Thermal desorption is reliable for chemical destruction in soil. Institutional controls and monitored natural attenuation are moderately reliable.	Enhanced bioremediation is reliable for chemical reduction in groundwater away from source areas. Institutional controls and monitored natural attenuation are moderately reliable.	Air sparging and SVE are reliable for chemical destruction in soil and groundwater. Institutional controls and monitored natural attenuation are moderately reliable.	All technology options are reliable.	All technology options are reliable.	All technology options are reliable.
Monitoring Considerations	Not applicable	Long-term groundwater monitoring is required.	Long-term groundwater monitoring is required.	Long-term groundwater monitoring is required.	Long-term groundwater monitoring is required.	Long term groundwater monitoring is required.	Long term groundwater monitoring is required.	Long term groundwater monitoring is required.
Availability of Services, Equipment, Materials, and Specialists	Not applicable.	Readily available.	Readily available.	Readily available.	Readily available.	Readily available.	Readily available.	Readily available.
Administrative Feasibility	Not applicable.	Feasible.	Feasible.	Feasible.	Feasible.	Feasible.	Feasible.	Feasible.
ESTIMATED TOTAL PRESENT WORTH COST	**$90,600**	**$698,200**	**$7,046,700**	**$9,905,600**	**$13,466,500**	**$14,453,800**	**$16,576,800**	**$20,372,500**

Notes:

ARAR Applicable or relevant and appropriate requirement
COC Contaminant of concern
PRB Permeable reactive barrier
RAO Remedial action objective
SVE Soil vapor extraction

TABLE 26
Summary of Estimated Capital Costs for Selected Remedy
Lockwood Solvent Groundwater Plume Site

Remedy Component	Unit	Unit Cost	Quantity	Cost
Site-wide Elements				
Connections to public water supply.	ea	$ 7,000.00	3	$ 21,000
GAC/UV wellhead treatment	ea	$ 5,000.00	3	$ 15,000
Extension of public water supply	ls	$ 25,000.00	1	$ 25,000
Controlled Groundwater Area	ls	$ 5,000.00	1	$ 5,000
Site Wide Treatment Barrier				
Injection Wells	ea	$ 3,237.98	60	$ 194,279
Anaerobic Amendments (single application)	lb	$ 5.35	15,750	$ 84,263
Brenntag PRB Construction				
Temporary Sheet Piling	ls	$ 546,510.26	1	$ 546,510
Excavation, backfill and revegetation	ls	$ 36,389.91	1	$ 36,390
Zero-valent Iron	ls	$ 720,110.83	1	$ 720,111
Brenntag NW Area Soil Thermal Desorption				
Excavation	ls	$ 183,070.00	0.63	$ 115,194
Thermal Desorption	ls	$ 459,273.00	0.63	$ 288,991
Brenntag Tank Farm Vadose Soil SVE				
SVE Extraction Wells and Appurtenances	ls	$ 77,223.00	0.27	$ 21,061
Carbon Adsorption	ls	$ 21,965.00	0.27	$ 5,990
Electrical	ls	$ 19,091.00	0.27	$ 5,207
Brenntag Permanganate Treatment				
Injection Wells and Appurtenances	ls	$ 72,440.00	1	$ 72,440
Permangenate System	ls	$ 34,506.00	1	$ 34,506
Permangenate Treatment	ls	$ 98,468.09	1	$ 98,468
Brenntag Treatment Barrier				
Injection Wells	ea	$ 3,237.98	100	$ 323,798
Anaerobic Amendments (single application)	lb	$ 5.35	24,630	$ 131,771
Beall Lactate Recirclulation System				
Extraction Wells and Appurtenances	ls	$ 46,416.00	1	$ 46,416
Injection Wells and Appurtenances	ls	$ 29,469.00	1	$ 29,469
Electrical	ls	$ 19,091.00	1	$ 19,091
Beall Plume Leading Edge Treatment Barrier				
Injection Wells	ea	$ 3,237.98	80	$ 259,038
Anaerobic Amendments (single application)	lb	$ 5.35	21,000	$ 112,350
Beall Vadose Soil SVE				
SVE Extraction Wells and Appurtenances	ls	$ 383,235.00	1	$ 383,235
Carbon Adsorption	ls	$ 96,081.00	1	$ 96,081
Electrical	ls	$ 18,498.00	1	$ 18,498
Other				
Non-hazardous soil and waste disposal	ls	$ 39,669.00	1	$ 39,669
Monitoring wells	ea	$ 7,619.00	25	$ 190,475
Decontamination Facilities	ls	$ 24,759.00	1	$ 24,759
			SUBTOTAL	$ 3,964,060
Construction Contingencies	25%			$ 991,015
			SUBTOTAL	$ 4,955,075
Project Management	5%			$ 247,754
Remedial Design	8%			$ 396,406
Construction Management	6%			$ 297,305
			SUBTOTAL	$ 941,464
TOTAL CAPITAL COSTS				**$ 5,896,539**

Notes
ls = lump sum
lb = pound
ea=each
GAC/UV = granular activated carbon/ultraviolet
MNA = monitored natural attenuation
SVE = soil vapor extraction
VOC = volatile organic compounds

TABLE 27
Summary of Estimated Operation, Maintenance and Periodic Costs for Selected Remedy
Lockwood Solvent Groundwater Plume Site

Remedy Component	Unit	Unit Cost	Quantity	Cost
ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS (Year 1-5)				
Recirculation System O&M and Monitoring	ls	$ 30,792	1	$ 30,792
Lactate	lb	$ 0.65	42,000	$ 27,300
Brenntag SVE System O&M and Monitoring	ls	$ 83,683	0.27	$ 22,823
Beall SVE System O&M and Monitoring	ls	$ 160,344	1	$ 160,344
Groundwater monitoring (VOCs &MNA)	ea	$ 1,491	346	$ 515,886
Groundwater monitoring (VOCs)	ea	$ 1,011	44	$ 44,484
Surface water monitoring (VOCs)	ea	$ 1,024	24	$ 24,576
Wellhead treatment monitoring and maintenance	ea	$ 500	3	$ 1,500
Annual information and education programs	ea	$ 5,000	1	$ 5,000
			SUBTOTAL	$ 832,704
O&M Contingencies	25%			$ 208,176
TOTAL YEARLY O&M COST				**$ 1,040,880**
ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS (Year 6-10)				
Recirculation System O&M and Monitoring	ls	$ 30,792	1	$ 30,792
Lactate	lb	$ 0.65	42,000	$ 27,300
Brenntag SVE System O&M and Monitoring	ls	$ 83,683	0.27	$ 22,823
Groundwater monitoring (VOCs &MNA)	ea	$ 1,491	173	$ 257,943
Groundwater monitoring (VOCs)	ea	$ 1,011	44	$ 44,484
Surface water monitoring (VOCs)	ea	$ 1,024	12	$ 12,288
Wellhead treatment monitoring and maintenance	ea	$ 500	3	$ 1,500
Annual information and education programs	ls	$ 5,000	1	$ 5,000
			SUBTOTAL	$ 402,129
O&M Contingencies	25%			$ 100,532
TOTAL YEARLY O&M COST				**$ 502,662**
ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS (Year 11-20)				
Groundwater monitoring (VOCs &MNA)	ea	$ 1,491	106	$ 158,046
Surface water monitoring (VOCs)	ea	$ 1,024	12	$ 12,288
Wellhead treatment monitoring and maintenance	ea	$ 500	3	$ 1,500
Annual information and education programs	ls	$ 5,000	1	$ 5,000
			SUBTOTAL	$ 176,834
O&M Contingencies	25%			$ 44,209
TOTAL YEARLY O&M COST				**$ 221,043**
ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS (Year 21-30)				
Groundwater monitoring (VOCs &MNA)	ea	$ 1,491	106	$ 158,046
Surface water monitoring (VOCs)	ea	$ 1,024	12	$ 12,288
Annual information and education programs	ls	$ 5,000	1	$ 5,000
			SUBTOTAL	$ 175,334
O&M Contingencies	25%			$ 43,834
TOTAL YEARLY O&M COST				**$ 219,168**
PERIODIC COSTS (with 25 percent contingency)				
PRB Iron Replacement (year 15)	ls	$ 1,303,011	1	**$ 1,628,764**
Anaerobic Amendments (year 3)	ls	$ 5.35	61,380	**$ 410,479**
Aerobic Amendments (year 6)	ls	$ 10	61,380	**$ 767,250**
5-Year Review	ls	$ 33,609	1	**$ 42,011**

Notes
ls = lump sum
lb = pound
ea=each
GAC/UV = granular activated carbon/ultraviolet
MNA = monitored natural attenuation
SVE = soil vapor extraction
VOC = volatile organic compounds

TABLE 28
30-Year Present Value Analysis for Selected Remedy
Lockwood Solvent Groundwater Plume Site

Year	Capital Costs	O&M Costs	Periodic Costs	Total Annual Expenditures	Discount Factor (7%)	Present Value
0	$ 5,896,539	0	0	$ 5,896,539	1	$ 5,896,539
1	0	$ 1,040,880	0	$ 1,040,880	0.9346	$ 972,807
2	0	$ 1,040,880	0	$ 1,040,880	0.8734	$ 909,105
3	0	$ 1,040,880	$ 410,479	$ 1,451,359	0.8163	$ 1,184,744
4	0	$ 1,040,880	0	$ 1,040,880	0.7629	$ 794,088
5	0	$ 1,040,880	$ 42,011	$ 1,082,892	0.713	$ 772,102
6	0	$ 502,662	$ 767,250	$ 1,269,912	0.6663	$ 846,142
7	0	$ 502,662	0	$ 502,662	0.6227	$ 313,008
8	0	$ 502,662	0	$ 502,662	0.582	$ 292,549
9	0	$ 502,662	0	$ 502,662	0.5439	$ 273,398
10	0	$ 502,662	$ 42,011	$ 544,673	0.5083	$ 276,857
11	0	$ 221,043	0	$ 221,043	0.4751	$ 105,017
12	0	$ 221,043	0	$ 221,043	0.444	$ 98,143
13	0	$ 221,043	0	$ 221,043	0.415	$ 91,733
14	0	$ 221,043	0	$ 221,043	0.3878	$ 85,720
15	0	$ 221,043	$ 1,670,775	$ 1,891,818	0.3624	$ 685,595
16	0	$ 221,043	0	$ 221,043	0.3387	$ 74,867
17	0	$ 221,043	0	$ 221,043	0.3166	$ 69,982
18	0	$ 221,043	0	$ 221,043	0.2959	$ 65,406
19	0	$ 221,043	0	$ 221,043	0.2765	$ 61,118
20	0	$ 221,043	$ 42,011	$ 263,054	0.2584	$ 67,973
21	0	$ 219,168	0	$ 219,168	0.2415	$ 52,929
22	0	$ 219,168	0	$ 219,168	0.2257	$ 49,466
23	0	$ 219,168	0	$ 219,168	0.2109	$ 46,222
24	0	$ 219,168	0	$ 219,168	0.1971	$ 43,198
25	0	$ 219,168	$ 42,011	$ 261,179	0.1842	$ 48,109
26	0	$ 219,168	0	$ 219,168	0.1722	$ 37,741
27	0	$ 219,168	0	$ 219,168	0.1609	$ 35,264
28	0	$ 219,168	0	$ 219,168	0.1504	$ 32,963
29	0	$ 219,168	0	$ 219,168	0.1406	$ 30,815
30	0	$ 219,168	$ 42,011	$ 261,179	0.1314	$ 34,319
TOTALS:	$ 5,896,539	$ 12,119,811	$ 3,058,560	$ 21,074,910		$ 14,347,919
PV:	$ 5,896,539	$ 6,924,176	$ 1,527,204	$ 14,347,920		
			TOTAL PRESENT VALUE			**$ 14,347,900**

Notes:

1 Capital costs are assumed to occur in year zero.

2 Total annual expenditure is the total cost per year with no discounting.

3 Present value (PV) is the total cost per year including a 7% discount factor for that year.

4 Total present value is rounded to the nearest $100.

Table 29
Soil Cleanup Levels for Brenntag Source Area
Lockwood Solvent Groundwater Plume Site

Media: Soil
Site Area: Brenntag Source Area
Available Use: Light Industrial
Controls to Ensure Restricted Use (if applicable): NA

Chemical of Concern	Cleanup Level	Basis for Cleanup Level	Risk At Cleanup Level
Tetrachloroethene	0.65	Leaching to groundwater	NA
Trichloroethene	0.72	Leaching to groundwater	NA
cis-1,2-dichloroethene	4.90	Leaching to groundwater	NA
Vinyl Chloride	0.16	Leaching to groundwater	NA

Notes:
NA not applicable
All soil units are milligram per kilogram

Table 30
Soil Cleanup Levels for Beall Source Area
Lockwood Solvent Groundwater Plume Site

Media: Soil
Site Area: Beall Source Area
Available Use: Light Industrial
Controls to Ensure Restricted Use (if applicable): NA

Chemical of Concern	Cleanup Level	Basis for Cleanup Level	Risk At Cleanup Level
Tetrachloroethene	0.22	Leaching to groundwater	NA
Trichloroethene	0.24	Leaching to groundwater	NA
cis-1,2-dichloroethene	1.64	Leaching to groundwater	NA
Vinyl Chloride	0.05	Leaching to groundwater	NA

Notes:
MCL Maximum contaminant level
NA not applicable
All soil units are milligram per kilogram

Table 31
Groundwater and Surface Water Cleanup Levels
Lockwood Solvent Groundwater Plume Site

Media: Groundwater and Surface Water
Site Area: Site Wide
Available Use: Mixed
Controls to Ensure Restricted Use (if applicable): NA

Chemical of Concern	Cleanup Level	Basis for Cleanup Level	Risk At Cleanup Level
Tetrachloroethene	5.0	MCL	NA
Trichloroethene	5.0	MCL	NA
cis-1,2-dichloroethene	70.0	MCL	NA
Vinyl Chloride	2.0	MCL	NA

Notes:

NA not applicable
All groundwater and surface water units are micrograms per liter